

CLAIMS

We claim:

1 1. A photomask used to form a partial-depth feature in a polymer film on a
2 semiconductor wafer, and, substantially simultaneously, used to form a full-depth feature in the
3 polymer film on the semiconductor wafer during one series of photo-imaging steps using exposure
4 tools capable of resolving a minimum resolvable size to form a feature completely through the
5 polymer film, the polymer film having a film thickness, the partial-depth feature having a depth
6 substantially less than the film thickness, the full-depth feature having a depth approximately equal
7 to the film thickness, the photomask comprising:

8 a transparent plate;

9 at least one full-depth producing pattern, each full-depth producing pattern
10 including an area of UV light-blocking material disposed on the transparent plate, the area having
11 a larger dimension and a smaller dimension, the smaller dimension being equal to or greater than
12 minimum resolvable size; and

13 a partial-depth producing pattern including a plurality of areas of UV light-
14 blocking material disposed on the transparent plate, each area of the plurality of areas having a
15 larger dimension and a smaller dimension, the smaller dimension being less than the minimum
16 resolvable size, each area being spaced from another area by a distance less than the minimum
17 resolvable size.

1 2. The photomask of claim 1, in which the partial-depth producing pattern produces
2 only one partial-depth feature in the polymer film.

1 3. The photomask of claim 2, in which each full-depth producing pattern produces a
2 full-depth feature in the polymer film.

1 4. The photomask of claim 1, in which the partial-depth feature produced in the
2 polymer film has a first width and in which the full-depth feature produced in the polymer film has
3 a second width, and in which the second width is less than or equal to the first width.

1 5. The photomask of claim 1, in which the material of the transparent plate is one of
2 glass and quartz.

1 6. The photomask of claim 1, in which the UV light-blocking material is chrome.

1 7. The photomask of claim 6, in which each area of the plurality of areas is a circle of
2 chrome.

1 8. The photomask of claim 6, in which each area of the plurality of areas is a line of
2 chrome.

1 9. A method of forming a partial-depth feature in a polymer film on a semiconductor
2 wafer using exposure tools having a critical dimension, comprising the steps of:

3 (a) disposing on a photomask a partial-depth producing pattern including a plurality
4 of areas of UV light-blocking material, each area having a smaller dimension less than the critical
5 dimension and being spaced apart a distance less than the critical dimension; and

6 (b) exposing the polymer film to the partial-depth producing pattern on the
7 photomask in a manner substantially the same as when exposing the polymer film to full-depth
8 producing images on the photomask; and

9 (c) developing the polymer film exposed to the partial-depth producing pattern on the
10 photomask in a manner substantially the same as when developing the polymer film exposed to a
11 full-depth producing pattern on the photomask.

1 10. The method of claim 9, in which the UV light-blocking material is chrome.

1 11. The method of claim 9, in which each area of the plurality of areas is a circle of
2 chrome.

1 12. The method of claim 9, in which each area of the plurality of areas is a line of chrome.

1 13. A method of altering an optical property of a surface of a polymer film, comprising
2 the steps of:

3 (a) disposing a layer of polymer film on a semiconductor wafer, the layer having a
4 surface with a first optical property;

5 (b) exposing the polymer film to a partial-depth producing pattern on a photomask;
6 and

7 (b) developing the exposed polymer film such that the surface of the polymer film has
8 a second optical property.

1 14. The method of claim 13, in which the optical property is reflectivity.

1 15. The method of claim 14, in which the reflectivity is reduced.

1 16. The method of claim 15, in which the partial-depth producing pattern includes
2 chrome disposed on the photomask.

1 17. A method to inscribe markings on a surface of a polymer film, comprising the steps
2 of:

3 (a) disposing a layer of polymer film on a semiconductor wafer, the layer having a
4 surface with no discernable markings;

5 (b) exposing the polymer film to a partial-depth producing pattern on a photomask,
6 the partial-depth producing pattern having one or more preselected shapes; and

7 (b) developing the exposed polymer film such that the one or more preselected
8 shapes are discernable on the surface of the polymer film.

1 18. The method of claim 17, in which the markings include alphanumerical information.

1 19. The method of claim 18, in which the partial-depth producing pattern includes
2 chrome disposed on the photomask.

1 20. The method of claim 19, in which the chrome is disposed on the photomask in the
2 preselected shape.

1 21. A method of making thinner a layer of a polymer film disposed on a semiconductor
2 wafer, comprising the steps of:

3 (a) providing a layer of polymer film on the semiconductor wafer, the layer having a
4 first thickness;

5 (b) exposing at least a portion of the polymer film to a partial-depth producing
6 pattern on at least a portion of a photomask; and

7 (b) developing the polymer film such that the at least a portion of the polymer film
8 exposed to the partial-depth producing pattern has a second thickness, the second thickness being
9 smaller than the first thickness.

1 22. The method of claim 21, in which the partial-depth producing pattern includes
2 chrome disposed on the photomask.

1 23. The method of claim 22, in which step (b) exposes the entire polymer film to the
2 partial-depth producing pattern on the photomask.

1 24. A method of using a photomask to form a feature in a layer of a negative-acting
2 photo-imageable polymer film, the feature having a smaller dimension greater than a critical
3 dimension of photolithography tools used, and in which the feature penetrates only partially
4 through the layer, the polymer film having a minimum structurally sound material width,
5 comprising the steps of:

6 (a) disposing on the photomask a plurality of areas of chrome, each area having a
7 smaller dimension smaller than the critical dimension and being spaced apart a distance smaller
8 than the critical dimension;

9 (b) exposing the polymer film to UV light shining through the photomask such that
10 the UV light is blocked by the areas of chrome; and

11 (c) developing the polymer film such that portions of the polymer film not exposed to
12 the UV light and portions of the polymer film exposed to the UV light and having a width
13 narrower than the minimum structurally sound material width, are removed, thereby forming the
14 feature.

1 25. The method of claim 24, in which layer has a thickness and in which the feature
2 penetrates a depth into the layer of 1-99% of the thickness.

1 26. The method of claim 24, in which the layer of polymer film is a passivation layer of a
2 chip scale package.